Chapter 1
Introduction

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The Wyoming State Engineer's Office (SEO) published the first State Framework Water Plan in 1973 under the Wyoming Water Planning Program. The publication presented a water resources plan for the entire state of Wyoming and included summary water plans for each of the state's seven major river drainages. In 1975, the Wyoming Legislature established the Wyoming Water Development Commission (WWDC) and Wyoming Water Development Office (WWDO) to coordinate planning, development and project management efforts for the state's water and related land resources. Between 1979 and 1995, the WWDO completed several, major river basin planning studies.

The development of the present State Water Planning Process began in 1997 when the state legislature directed WWDC to conduct a feasibility study in collaboration with the University of Wyoming (UW), the Water Resources Data System (WRDS) and the SEO that included public input and compilation of a statewide water inventory. Based on the feasibility study, the Legislature accepted the recommended planning framework and funded the Statewide Water Planning Process in 1999 to update the original 1973 State Framework Water Plan, and specifically to:

- Inventory the state's water resources and related lands.
- Summarize the state's present water uses and project future water needs.
- Identify alternatives to meet projected future water needs.
- Provide water resource planning direction to the state of Wyoming for a 30-year time-frame.
- The Wyoming Framework Water Plan (WWC Engineering and others, 2007), compiled between 2001 and 2006, summarized the separate water plans for Wyoming's seven major river basins (**Fig. 1-1**).

The technical memoranda of the existing Bear River Basin water plans (Forsgren and Associates, 2001; Wyoming Water Development Office (WWDO), 2012) contain ground water resource investigations that thoroughly examine the basin's groundwater resources and their use. This memorandum represents the most current assessment of the groundwater resources in the Bear River Basin; it updates and expands the information presented in the previous groundwater investigations. The data contained in this memorandum are a compilation of existing information obtained by several state and federal agencies. While original maps and tables were developed, and existing maps and tables were updated and modified, no original research was conducted for this memorandum.

The format of this update follows the general layout of other, recent groundwater determination updates co-authored by the Wyoming State Geological Survey (WSGS) and U.S. Geological Survey (USGS) for the Wind/Bighorn River Basin (2012), the Green River Basin (2010), and the Platte River Basin (2013); this memorandum incorporates much of the content of these three, previous studies, frequently without citation.

1.1 Interagency Agreement and scope

The WWDC and WSGS entered into an Interagency Agreement in June 2010 to update the groundwater information contained in the previous Bear River Basin water plans (Forsgren and Associates, 2001; WWDO, 2012). The previous Bear River water plans are available on the WWDC website at http://waterplan.state.wy.us/plan/bear/bear-plan.html. The agreement outlined the following tasks for this update of the Bear River Basin water plans:

- **Identify the major (most widely used) aquifers in the Bear River Basin.** To make this determination, the USGS defined all of the aquifers and confining units in the Bear River Basin and presented the information on hydrostratigraphic nomenclature charts (**Pl. 5**). Based on these detailed analyses, the Geographic Information System (GIS) geologic units mapped on **Plate 1** and described in Appendix A were organized into a comprehensive hydrostratigraphic chart

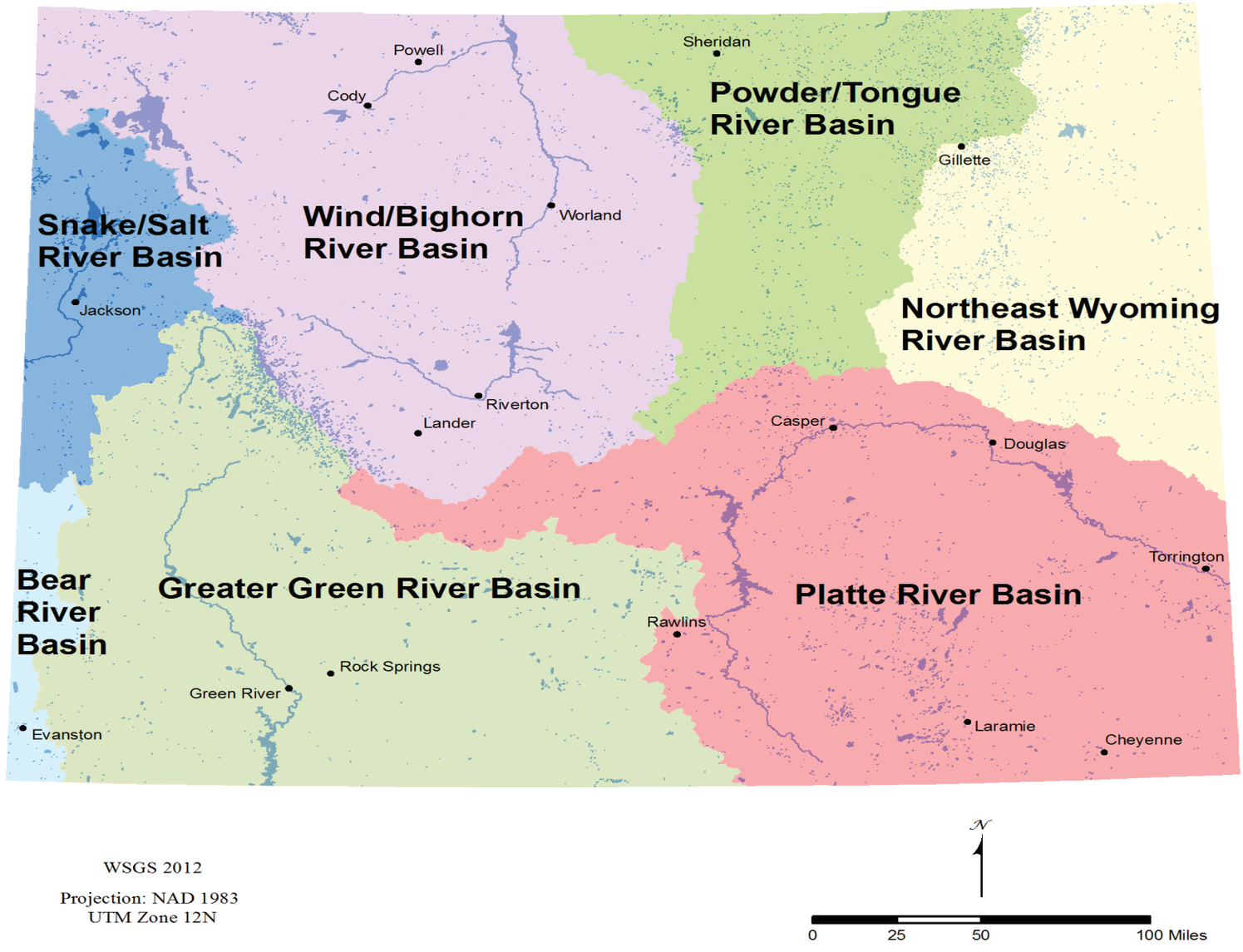

Figure 1-1. Major drainage basins, Wyoming.

and surface hydrogeology map for the Bear River Basin (**Pl. 2**). In some cases, two or more minor aquifers that are hydrologically connected have been grouped together and treated as a single combined hydrogeologic unit. The general geology of the Bear River Basin is discussed in **Chapter 4**. Individual Bear River Basin aquifers are discussed in detail in **Chapter 7**.

- **Define the three-dimensional extent of the aquifers.**
- **Plate 2** is a map of the outcrop areas for the basin's aquifers and confining units in the Bear River Basin. Five cross sections (**Figs. 4-2** through **4-6**) illustrate the subsurface configuration of the geologic units that constitute the hydrogeologic units at selected areas within the basin. Isopach maps with substantial coverage of the major aquifers in the Bear River Basin are unavailable.
- Describe the following hydraulic, hydrogeologic, and hydrogeochemical properties of the aquifers and confining units:
- Physical characteristics – **Chapters 4** and **7** discuss the lithologic and hydrogeologic characteristics of the hydrogeologic units identified in **Plate 2**.
- Water chemistry with comparisons to applicable state and federal regulatory standards by class of use – **Chapters 5** and **7** contain extensive discussions of basin water quality with comparisons to regulatory standards. Statistical analyses of water chemistry are presented in **Appendices E** and **F**.
- Principal potential pollutants – **Chapter 5** contains a discussion of potential sources of pollution and maps of these facilities are provided in **Figures 5-4** through **5-10**.
- **Estimate the quantity of water in the aquifers.**
- Data sufficient for a basin-wide aquifer-specific assessment of groundwater quantity is not available and is unlikely to ever be developed. The complex geology of most of the Bear River Basin does not lend itself to the general assumptions about aquifer properties, geometry, and saturated thickness that would be required for a plausible estimate of total and producible groundwater resources. The most important aquifers in the Bear River Basin, that include the Bear River alluvium, Wasatch Formation, Gannett Group, and Nugget Sandstone have been described in numerous specific studies that are more comprehensive and relevant than a summary estimate. Groundwater resource estimates are addressed in this Technical Memorandum by analysis of recharge (**Chapter 6**) and a basin-wide water balance (**Chapter 8**).
- **Describe the aquifer recharge areas.**
- **Plate 2** is a map of the outcrop areas of aquifers and confining units in the Bear River Basin. Maps that depict the outcrop areas used to calculate the annual rate of recharge for specific aquifers and logical groups of aquifers throughout the Bear River Basin are provided in **Figures 6-1** through **6-4.** Recharge is discussed in **Section 5.1** and **Chapter 6**.
- **Estimate aquifer recharge rates.** Existing maps depicting average annual precipitation (**Fig. 3-3**) and estimated recharge rates (**Fig. 5-2**) over the entire Bear River Basin were adapted for presentation in this Technical Memorandum. Existing annual recharge rates were multiplied by aquifer outcrop areas (**Figs. 6-1** through **6-4**) to estimate a range of annual recharge volumes for individual and combined aquifers. The results of these estimates are summarized in **Tables 6-1** through **6-3** and discussed in **Section 6-2**. **Figure 6-5** represents recharge as a percentage of precipitation and **Section 6-2** describes how recharge efficiency varies by individual and combined aquifers overall within the Bear River Basin.
- **Estimate the "safe yield"** potential for the aquifers and describe implications of hydrologically connected groundwater and surface water.

- The concept of "safe yield" is discussed in **Section 5.1.4**. This report provides estimates of total (average annual) recharge for the Bear River Basin in **Chapter 6**, and compares these recharge estimates to current groundwater withdrawals in **Chapter 8**.
- **Describe and evaluate existing groundwater models:**
  Existing groundwater models are identified and evaluated; and recommendations for future groundwater modeling in the Bear River Basin are discussed in **Chapter 7**.
- **Identify future groundwater development opportunities to satisfy projected agricultural, municipal, and industrial demands:**
  Several approaches to address future groundwater development potential are discussed in **Chapter 9**.

    - General and aquifer-specific hydrogeology relative to groundwater development potential is discussed in **Chapters 5** through **7**.
    - **Figures 8-1** through **8-6** show wells permitted in the Bear River Basin by the SEO through February 27, 2012. These Figures include selected groundwater permit statistics and illustrate historic groundwater development patterns. SEO permits issued between January 1, 2001 and February 27, 2012, shown on inset tables contained within these figures, illustrate the focus of recent groundwater development efforts. Existing groundwater development in the Bear River Basin is discussed in **Chapters 7** and **9**.
    - A summary of groundwater development studies and projects in the Bear River Basin, sponsored by the WWDC, is included in Appendix B of this Technical Memorandum. The development potential of specific aquifers based on information compiled from these and other previous studies is described in **Chapter 7**.
    - Groundwater development prospects for the Bear River Basin, identified in the ground water resource investigations of previous Bear River Basin water plans (Forsgren and Associates, 2001; WWDO, 2012) are briefly discussed in **Chapter 9**.
    - Current WWDC and SEO projects related to groundwater development in the Bear River Basin are discussed in **Chapter 9**.

1.2 Agency participation

This Technical Memorandum is the result of a cooperative effort by the WWDC/WWDO, WSGS, USGS, and the Water Resources Data System (WRDS). The SEO and the Wyoming Department of Environmental Quality (WDEQ) contributed significant resources for developing some of the data presented in this Technical Memorandum.

- The WWDO and WRDS provided the WSGS with overall program guidance and standards, software, and format requirements for deliverables (maps, databases, metadata, tables, graphs, etc.).
- The WSGS was the primary compiler of the information developed in **Chapters 1, 2, 3, 4, 5, 6, 8,** and **9**.
- The USGS, under contract with the WSGS, compiled the information used in **Chapter 7** and **Section 5.6.1**.
- The WSGS and USGS cooperated on sections of **Chapters 5** and **9**.
- WRDS provided assistance by providing hard copies of the final Technical Memorandum and will feature the associated deliverables on its website at http://www.wrds.uwyo.edu/ on behalf of WWDC/WWDO.

The WWDO, the water development planning agency for Wyoming, administers publicly-funded development, construction, rehabilitation, and related groundwater projects through its

professional, legal, and support staff at the WWDO.

The WSGS is a separate operating agency under the executive branch of state government (Wyoming State Statutes 9-2-801, 9-2-803 through 9-2-810). The WSGS's purposes are 1) to study, examine, and understand the geology, mineral resources, and physical features of the state; 2) to prepare, publish, and distribute (free or for sale) reports and maps of the state's geology, mineral resources, and physical features; and 3) to provide information, advice, and services related to the geology, mineral resources, and physical features of the state. The agency's mission is to "promote the beneficial and environmentally sound use of Wyoming's vast geologic, mineral, and energy resources, while helping protect the public from geologic hazards." By providing accurate information and expanding knowledge through the application of geologic principles, the WSGS contributes to the economic growth of the state and improves the quality of life of Wyoming's residents. WSGS hydrogeologists conduct research; compile data; create and distribute maps and reports; and address inquiries to assist citizens, industry, and state and federal agencies in planning, decision making, and analysis of groundwater and surface water issues.

The USGS provides data, maps, reports, and other scientific information to help individuals and local and state governments manage, develop, and protect the water, energy, mineral, and land resources of Wyoming and the United States. The agency's mission is to "provide reliable scientific information to describe and understand the earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life." To meet these goals, the USGS employs experienced scientists and support staff from a wide range of earth and life science disciplines.

WRDS is a clearinghouse for hydrological data. WRDS is funded by the WWDO to provide a variety of services, including the online provision of groundwater resources information, maps, and publications.

The SEO and WWDO cooperate on many projects. SEO personnel attend meetings on river basin planning and other WWDC projects. WWDC-funded groundwater development projects generally require permits from both the SEO and WDEQ (K. Clarey, WWDO, pers. commun.).

1.3 Legal and institutional framework

Wyoming laws that govern the appropriation, development, and beneficial use of water resources are based on the doctrine of prior appropriation, commonly stated as "first in time is first in right." This means that, during periods of limited supply, the first party to put a source of water to beneficial use has a "priority" water-right honored prior to those of other, later users. An exception is that municipalities can obtain water-rights from earlier priority uses through eminent domain (Wyoming State Statutes 1-26). Because all waters within Wyoming are property of the state, a water-right does not grant ownership, but only the right to use water for beneficial purposes. Use of water resources for domestic and livestock purposes customarily take precedence over other uses. In Wyoming, water-rights are attached to the land and can be transferred. The laws and regulations pertaining to the appropriation, development, and beneficial use of groundwater are administered by the SEO and Board of Control comprised of the superintendents of the four state water divisions and the State Engineer. The entire Bear River Basin area is included in SEO Water Division IV. A comprehensive discussion of the laws that govern Wyoming water resources is provided online at: http://seo.state.wy.us/PDF/b849r.pdf

1.3.1 Wyoming water law – groundwater appropriation, development, and use

Groundwater within the state is owned and controlled by the state of Wyoming. Under Wyoming law, groundwater includes any water (including geothermal waters) under the land surface or under the bed of any body of surface water. The SEO is responsible for the permitting and orderly development of groundwater in

Wyoming and for protecting groundwater resources from waste and contamination. The updated Wind/Bighorn River Basin Water Plan (MWH and others, 2010) provides the following discussion of Wyoming water law specific to groundwater:

> "Wyoming's groundwater laws were originally enacted in 1945 and amended in 1947. These laws were replaced by new groundwater laws on March 1, 1958, which were then amended in 1969. Groundwater is administered on a permit basis. The acquisition of groundwater rights generally follows the same permitting procedures as surface water rights, except that a map is not required at the time of permit application. Applications are submitted to and approved by the SEO prior to drilling a well. With the completion of the well and application of the water to a beneficial use, the appropriation can then be adjudicated. The issuance of well permits carries no guarantee of a continued water level or artesian pressure."
>
> "As with surface water rights, groundwater rights are administered on a priority basis. For all wells drilled prior to April 1, 1947, a statement of claim process was followed to determine the priority date of the well. For wells drilled between April 1, 1947 and March 1, 1958, the priority date is the date the well was registered. For wells drilled after March 1, 1958, the priority date is the date the application was received at the WSEO."
>
> "Domestic and stock wells are those wells used for non-commercial household use, including lawn and garden watering that does not exceed one acre in aerial extent, and the watering of stock. The yield from these wells cannot exceed 25 gallons per minute (gpm). Prior to the 1969 amendment, domestic and stock wells were exempt from the requirement to obtain a permit and held a preferred right over other wells. The 1969 amendment established priorities for domestic and stock wells similar to those for other wells. The Groundwater Division also issues permits for spring developments where the total yield or flow of the spring is 25 gpm or less and where the proposed use is for stock and/or domestic purposes."

1.3.2 Interstate agreements

Although the Wyoming Constitution establishes that all surface water and groundwater within Wyoming's borders is owned by the state, the right to put surface water and groundwater to beneficial use is permitted via water rights issued by the SEO and adjudicated by the Wyoming Board of Control. Surface water resources of Wyoming are subject to interstate agreements that limit how much streamflow can be depleted before leaving the state. Furthermore, conflicts among users within the state or across state lines can occur where groundwater extraction may affect surface flows. Although interconnection between groundwater and surface water is not currently a significant water-rights issue in the Bear River Basin, it could become a point of contention in the future as the basin's population grows.

To avert present and future conflicts over the allocation and use of flows within the Bear River Basin, the states of Idaho, Utah, and Wyoming agreed to the "Amended Bear River Compact" in 1978. The compact divides water administration in the Bear River among three geographically defined divisions. The Upper Division encompasses the reach of the Bear River that extends from its headwaters in the Uinta Mountains to the Pixley diversion dam in sec. 25, T. 23 N., R. 120 W., of the Sixth Principal Meridian in Wyoming. During a compact defined water emergency in the Upper Division, percentage allocations are made to the Utah and Wyoming Sections and distribution of divertible flow is managed by diversion by the two states. The Central Division extends from below Pixley Dam to the Stewart diversion dam in sec, 34, T. 13 S., R. 44 E., of the Boise Base Meridian in Idaho; during a water emergency, divertible flow is allocated by percentage to Wyoming and Idaho. In the Lower Division, which extends from the Stewart Dam to the Great Salt Lake, divertible flows are allocated by a commission approved delivery schedule.

The portion of the Bear River drainage basin examined in this report consists of the entire Upper Division and those parts of the Central Division that are tributary to the Bear River upstream of the Idaho-Wyoming border (**Fig. 3-1**). **Appendix D** (SEO, 2006) contains a copy of the Amended Bear River Compact (1978). The compact is administered by the Bear River Commission, consisting of three commissioners from each signatory state. The Interstate Streams Division of the SEO, in conjunction with SEO Water District IV staff, administers the provisions of the compact that fall under the authority of the state of Wyoming. A map of the larger Bear River Basin depicting the three divisions can be found online: http://bearrivercommission.org/docs/16thpercent20final.pdf.

Article VI of the compact allocates an additional 13,000 acre-feet annual total of surface and connected groundwater each to Wyoming and that portion of Utah above Stewart Dam for beneficial uses applied on or after January 1, 1976. Historically, Wyoming has used only a small portion of this additional allocation, so it is likely that future groundwater development in the Bear River Basin will be allowed so that Wyoming can utilize the 13,000 acre-feet allocation. In Wyoming, the SEO monitors surface water and connected groundwater depletions of the additional allocation.

1.3.3 Wyoming water law – groundwater quality

The Denver office of the U.S. Environmental Protection Agency (EPA) Region 8 has primary control (primacy) over Wyoming's public drinking water supplies. Wyoming is the only state in which EPA has primacy over drinking water systems. The EPA monitors water quality for the several hundred public water systems in Wyoming. Information on Wyoming's public drinking water systems is available on the EPA Wyoming Drinking Water website:
http://www.epa.gov/safewater/dwinfo/wy.html

Except on the Wind River Indian Reservation, the DEQ enforces groundwater quality regulations under the Wyoming Environmental Quality Act, with guidance from the Wyoming Environmental Quality Council. The DEQ administers provisions of the federal Clean Water Act Amendment of 1972 (Section 208) that provide for water quality management by state and local governments, as well as provisions of the Federal Water Pollution Act, by developing a State Water Quality Plan approved by the EPA. In general, operations under the jurisdiction of the Wyoming Oil and Gas Conservation Commission (WOGCC), U.S. Bureau of Land Management (BLM), EPA, or U.S. Forest Service that cause groundwater contamination are referred to the DEQ. The WOGCC has jurisdiction over Class II underground injection wells (**Chapter 5**) dedicated to disposal of produced water from state and federal oil and gas leases.

1.3.4 Other agencies

The U.S. Bureau of Reclamation (BOR), an agency under the U.S. Department of the Interior, oversees and manages water resources specifically related to the operation of numerous water diversions, delivery, storage, and hydroelectric power generation projects built by the federal government throughout the western United States. The BOR cooperates with the SEO and the WWDC (primarily through the SEO) but as a federal agency, has autonomy to execute some programs unilaterally. The BOR coordinates releases from Wyoming's reservoirs with the SEO. (K. Clary, WWDO, pers. commun.). Although not a primary area of concern, the BOR and the following other agencies are occasionally involved in groundwater resource issues:

- Wyoming Department of Agriculture
- U.S. Department of Agriculture and the
- U.S. National Park Service
- U.S Army Corps of Engineers
- U.S. Office of Surface Mining, Reclamation and Enforcement
- U.S Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement
- U.S Department of Energy
- U.S. Nuclear Regulatory Commission

1.4 Authorship

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